

What is claimed is:

1. An apparatus for estimating a residual gas amount of an internal combustion engine provided with a variable valve mechanism that varies at least an operating characteristic of an intake valve, comprising:

a valve operating characteristic detecting unit that detects a valve operating characteristic which is varied by said variable valve mechanism;

an actual intake air amount measuring unit that measures an actual intake air amount of said engine; and

a residual gas amount calculating unit that calculates a valve opening area at a valve overlap time based on detected valve operating characteristic, and calculates a residual gas amount of the engine based on calculated valve opening area and said actual intake air amount of the engine.

2. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 1,

wherein said residual gas amount calculating unit calculates said valve opening area at the valve overlap time based on opening timing and a valve lift amount of said intake valve.

3. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 1,

wherein said residual gas amount calculating unit;

calculates a basic residual gas amount based on said actual intake air amount of the engine,

calculates a spit-back gas amount at the valve overlap time based on said valve opening area at the valve overlap time, and

sets a resultant obtained by adding calculated spit-back gas amount at the valve overlap time to said basic residual gas amount, as said residual gas amount of the engine.

4. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 3,

wherein said residual gas amount calculating unit;

calculates a spit-back gas amount for when closing timing of an exhaust valve is made to be reference timing, based on said valve opening area at the valve overlap time, and

sets a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing of said exhaust valve, as said spit-back gas amount at

the valve overlap time.

5. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 3,

wherein said residual gas amount calculating unit;

calculates a spit-back gas amount for when closing timing of an exhaust valve is made to be reference timing and a valve lift amount of said exhaust valve is made to be a reference valve lift amount, based on said valve opening area at the valve overlap time, and

sets a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing and an actual valve lift amount of said exhaust valve, as said spit-back gas amount at the valve overlap time.

6. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 3,

wherein said residual gas amount calculating unit;

calculates a residual gas amount for when closing timing of an exhaust valve is made to be reference timing, based on said actual intake air amount of the engine, and

sets a resultant obtained by correcting calculated residual gas amount according to actual closing timing of said exhaust valve, as said basic residual gas amount.

7. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 1, further comprising;

an operating condition detecting unit that detects an operating condition inclusive of an engine intake pressure or an engine rotation speed,

wherein said residual gas amount calculating unit sets a resultant obtained by correcting a residual gas amount calculated when the operating condition of said engine is made to be a reference condition, according to at least one of an engine actual intake pressure and an engine actual rotation speed, as said residual gas amount of the engine.

8. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 1,

wherein said actual intake air amount measuring unit calculates said actual intake air amount of the engine based on said valve operating characteristic of said intake valve.

9. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 1,

wherein said actual intake air amount measuring unit comprises an intake air amount detecting sensor, and calculates said actual intake air amount of the engine based on a detection value of said intake air amount detecting sensor.

10. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 1,

wherein said valve opening area is a total opening area of said intake valve and an exhaust valve.

11. An apparatus for estimating a residual gas amount of an internal combustion engine according to claim 1,

wherein said valve opening area is an opening area of said intake valve.

12. An apparatus for estimating a residual gas amount of an internal combustion engine provided with a variable valve mechanism that varies at least an operating characteristic of an intake valve, comprising:

valve operating characteristic detecting means for detecting a valve operating characteristic which is varied by said variable valve mechanism;

actual intake air amount measuring means for measuring an actual intake air amount of said engine;

valve opening area calculating means for calculating a valve opening area at a valve overlap time based on said valve operating characteristic; and

residual gas amount calculating means for calculating a residual gas amount of the engine based on said actual intake air amount of the engine and said valve opening area at the valve overlap time.

13. A method of estimating a residual gas amount of an internal combustion engine provided with a variable valve mechanism that varies at least an operating characteristic of an intake valve,

wherein a valve opening area at a valve overlap time is calculated based on a valve operating characteristic which is varied by said variable valve mechanism, and a residual gas amount of said engine is calculated based on calculated valve opening area and said actual intake air amount of the engine.

14. A method of estimating a residual gas amount of an internal combustion engine according to claim 13,

wherein said valve opening area at the valve overlap time is calculated based on opening timing and a valve lift amount of said intake valve.

15. A method of estimating a residual gas amount of an internal combustion engine according to claim 13,

wherein a basic residual gas amount is calculated based on said actual intake air amount of the engine,

a spit-back gas amount at the valve overlap time is calculated based on said valve opening area at the valve overlap time, and

a resultant obtained by adding calculated spit-back gas amount at the valve overlap time to said basic residual gas amount, is set as said residual gas amount of the engine.

16. A method of estimating a residual gas amount of an internal combustion engine according to claim 15,

wherein a spit-back gas amount for when closing timing of an exhaust valve is made to be reference timing, is calculated based on said valve opening area at the valve overlap time, and

a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing of said exhaust valve, is set as said spit-back gas amount at the valve overlap time.

17. A method of estimating a residual gas amount of an internal combustion engine according to claim 15,

wherein a spit-back gas amount for when closing timing of an exhaust valve is made to be reference timing and a valve lift amount of said exhaust valve is made to be a reference valve lift amount, is calculated based on said valve opening area at the valve overlap time, and

a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing and an actual valve lift amount of said exhaust valve, is set as said spit-back gas amount at the valve overlap time.

18. A method of estimating a residual gas amount of an internal combustion engine according to claim 15,

wherein a residual gas amount for when closing timing of an exhaust valve is made to be reference timing, is calculated based on said actual intake air amount of the engine, and

a resultant obtained by correcting calculated residual gas amount according to actual closing timing of said exhaust valve, is set as said basic residual gas amount.

19. A method of estimating a residual gas amount of an internal combustion engine according to claim 13,

wherein a resultant obtained by correcting a residual gas amount calculated when the operating condition of said engine is made to be a reference condition, according to at least one of an engine actual intake pressure and an engine actual rotation speed, is set as said residual gas amount of the engine.

20. A method of estimating a residual gas amount of an internal combustion engine according to claim 13,

wherein said actual intake air amount of the engine is calculated based on said valve operating characteristic of said intake valve.

21. A method of estimating a residual gas amount of an internal combustion engine according to claim 13,

wherein said actual intake air amount of the engine is calculated based on a detection value of an intake air amount detecting sensor.

22. A method of estimating a residual gas amount of an internal combustion engine according to claim 13,

wherein said valve opening area is a total opening area of said intake valve and an exhaust valve.

23. A method of estimating a residual gas amount of an internal combustion engine according to claim 13,

wherein said valve opening area is an opening area of said intake valve.

24. An apparatus for controlling an intake air amount of an internal combustion engine provided with a variable valve mechanism that varies at least an operating characteristic of an intake valve, comprising:

an operating condition detecting unit that detects an operating condition of said engine;

an actual intake air amount measuring unit that measures an actual intake air amount of said engine;

a valve operating characteristic detecting unit that detects a valve operating characteristic which is varied by said variable valve mechanism; and

a control unit that sets a target valve operating characteristic according to the operating condition of the engine, and controls said variable valve mechanism so that the valve operating characteristic of said intake valve reaches said target valve operating characteristic,

wherein said control unit;

sets a target intake air amount equivalent to a target torque based on the

operating condition of the engine,

calculates a valve opening area at a valve overlap time based on detected valve operating characteristic,

calculates a residual gas amount of said engine based on calculated valve opening area and said actual intake air amount of the engine, and

sets said target valve operating characteristic based on said target intake air amount and said residual gas amount of the engine.

25. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24,

wherein said control unit;

calculates a target volume flow ratio in said intake valve by dividing said target intake air amount by an engine rotation speed and total cylinder volume,

corrects said target volume flow ratio according to said residual gas amount of the engine, and

sets said target valve operating characteristic based on corrected target volume flow ratio.

26. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24,

wherein said control unit calculates said valve opening area at the valve overlap time based on opening timing and a valve lift amount of said intake valve.

27. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24,

wherein said control unit;

calculates a basic residual gas amount based on said actual intake air amount of the engine,

calculates a spit-back gas amount at the valve overlap time based on said valve opening area at the valve overlap time, and

sets a resultant obtained by adding calculated spit-back gas amount at the valve overlap time to said basic residual gas amount, as said residual gas amount of the engine.

28. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 27,

wherein said control unit;

calculates a spit-back gas amount for when closing timing of an exhaust valve is made to be reference timing, based on said valve opening area at the valve overlap time,

and

sets a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing of said exhaust valve, as said spit-back gas amount at the valve overlap time.

29. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 27,

wherein said control unit;

calculates a spit-back gas amount for when closing timing of an exhaust valve is made to be reference timing and a valve lift amount of said exhaust valve is made to be a reference valve lift amount, based on said valve opening area at the valve overlap time, and

sets a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing and an actual valve lift amount of said exhaust valve, as said spit-back gas amount at the valve overlap time.

30. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 27,

wherein said control unit;

calculates a residual gas amount for when closing timing of an exhaust valve is made to be reference timing, based on said actual intake air amount of the engine, and

sets a resultant obtained by correcting calculated residual gas amount according to actual closing timing of said exhaust valve, as said basic residual gas amount.

31. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24, further comprising;

an operating condition detecting unit that detects an operating condition inclusive of an engine intake pressure or an engine rotation speed,

wherein said control unit sets a resultant obtained by correcting a residual gas amount calculated when the operating condition of said engine is made to be a reference condition, according to at least one of an engine actual intake pressure and an engine actual rotation speed, as said residual gas amount of the engine.

32. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24,

wherein said actual intake air amount measuring unit calculates said actual intake air amount of the engine based on said valve operating characteristic of said intake valve.

33. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24,

wherein said actual intake air amount measuring unit comprises an intake air amount detecting sensor, and calculates said actual intake air amount of the engine based on a detection value of said intake air amount detecting sensor.

34. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24,

wherein said valve opening area is a total opening area of said intake valve and an exhaust valve.

35. An apparatus for controlling an intake air amount of an internal combustion engine according to claim 24,

wherein said valve opening area is an opening area of said intake valve.

36. An apparatus for controlling an intake air amount of an internal combustion engine provided with a variable valve mechanism that varies at least an operating characteristic of an intake valve, comprising:

operating condition detecting means for detecting an operating condition of said engine;

actual intake air amount measuring means for measuring an actual intake air amount of said engine;

valve operating characteristic detecting means for detecting a valve operating characteristic which is varied by said variable valve mechanism; and

target intake air amount setting means for setting a target intake air amount equivalent to a target torque based on the operating condition of the engine;

residual gas amount calculating means for calculating a valve opening area at a valve overlap time based on the valve operating characteristic which is varied by said variable valve mechanism, and for calculating a residual gas amount of said engine based on calculated valve opening area and said actual intake air amount of the engine;

target valve operating characteristic setting means for setting a target valve operating characteristic based on said target intake air amount and said residual gas amount of the engine; and

variable valve mechanism control means for controlling said variable valve mechanism so that the valve operating characteristic of said intake valve reaches said target valve operating characteristic.

37. A method of controlling an intake air amount of an internal combustion engine provided with a variable valve mechanism that varies at least an operating characteristic

of an intake valve, comprising:

setting a target intake air amount equivalent to a target torque based on an operating condition of said engine;

calculating a valve opening area at a valve overlap time based on the valve operating characteristic which is varied by said variable valve mechanism;

calculating a residual gas amount of said engine based on said valve opening area at the valve overlap time and an actual intake air amount of said engine;

setting a target valve operating characteristic based on said target intake air amount and said residual gas amount of the engine; and

controlling said variable valve mechanism so that the valve operating characteristic of said intake valve reaches said target valve operating characteristic.

38. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein a target volume flow ratio in said intake valve is calculated by dividing said target intake air amount by an engine rotation speed and total cylinder volume,

said target volume flow ratio is corrected according to said residual gas amount of the engine, and

said target valve operating characteristic is set based on corrected target volume flow ratio.

39. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein said valve opening area at the valve overlap time is calculated based on opening timing and a valve lift amount of said intake valve.

40. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein a basic residual gas amount is calculated based on said actual intake air amount of the engine,

a spit-back gas amount at the valve overlap time is calculated based on said valve opening area at the valve overlap time, and

a resultant obtained by adding calculated spit-back gas amount at the valve overlap time to said basic residual gas amount, is set as said residual gas amount of the engine.

41. A method of controlling an intake air amount of an internal combustion engine according to claim 40,

wherein a spit-back gas amount for when closing timing of an exhaust valve is

made to be reference timing, is calculated based on said valve opening area at the valve overlap time, and

a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing of said exhaust valve, is set as said spit-back gas amount at the valve overlap time.

42. A method of controlling an intake air amount of an internal combustion engine according to claim 40,

wherein a spit-back gas amount for when closing timing of an exhaust valve is made to be reference timing and a valve lift amount of said exhaust valve is made to be a reference valve lift amount, is calculated based on said valve opening area at the valve overlap time, and

a resultant obtained by correcting calculated spit-back gas amount according to actual closing timing and an actual valve lift amount of said exhaust valve, is set as said spit-back gas amount at the valve overlap time.

43. A method of controlling an intake air amount of an internal combustion engine according to claim 40,

wherein a residual gas amount for when closing timing of an exhaust valve is made to be reference timing, is calculated based on said actual intake air amount of the engine, and

a resultant obtained by correcting calculated residual gas amount according to actual closing timing of said exhaust valve, is set as said basic residual gas amount.

44. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein a resultant obtained by correcting a residual gas amount calculated when the operating condition of said engine is made to be a reference condition, according to at least one of an engine actual intake pressure and an engine actual rotation speed, is set as said residual gas amount of the engine.

45. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein said actual intake air amount of the engine is calculated based on said valve operating characteristic of said intake valve.

46. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein said actual intake air amount of the engine is calculated based on a

detection value of an intake air amount detecting sensor.

47. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein said valve opening area is a total opening area of said intake valve and an exhaust valve.

48. A method of controlling an intake air amount of an internal combustion engine according to claim 37,

wherein said valve opening area is an opening area of said intake valve.